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Demographic Impacts of Utility Rate Designs[1]

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Introduction

Historically, utility customers have been differentiated into various customer classes, based on their utility service demand characteristics. In this paper we argue that greater differentiation, if based on value and cost of service, can be justified on grounds of economic efficiency, and if done properly can also promote economic equity. This would require a break with traditional customer classifications. With this break, more detailed information on how and why certain utility services are consumed would be required.

Traditionally, a great deal of effort has been expended in cost of service studies. One purpose has been the allocation of cost among various customer classes. Unfortunately, little is known about the structure of demand among sub-classes of consumers. What is generally known comes from demand or load studies which are invariably conducted along lines of traditionally established customer classifications. It is typically assumed that demand within these categories is homogeneous or that electric demand differences are insignificant and can be ignored.

However, there is no reason to assume electricity demand within a broadly defined customer class is homogeneous and without differences. Furthermore, with a growing emphasis by public utility commissions on demand-side management and equity, a fuller characterization of electric demand by population group may be both useful and practical. Unexploited differences in electricity demand are useful in that they provide an opportunity to achieve greater efficiency through the implementation of non-uniform pricing strategies (see Brown, and Sibley pp. 162-167) and are practical in that they will promote fairer and more equitable pricing schemes.

In line with the issue of heterogeneity, within the residential customer class, is the differential impact that different utility rates might have on different population groups. The purpose of this paper is to show how differences in the pattern of energy use may give rise to disparate economic impacts depending on the rate structure and how more equitable and efficient outcomes might be achieved if these differences are taken into account. For this purpose, an analytical model has been developed under the auspices of the U.S. Department of Energy, Office of Economic Impact and Diversity.

The Energy Policy Socioeconomic Impact Model (EPSIM), an econometric simulation model, has been developed to assess the economic impact of utility rate designs and demand-side management programs on various population groups. The following discussion provides a conceptual description of the theoretical underpinnings associated with the EPSIM.

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Minorities and Patterns of Electricity Use

Within the residential class, the empirical evidence strongly indicates the level and nature of electricity consumption by disparate population groups are different. For a number of years, the Office of Economic Impact and Diversity, U.S. Department of Energy has funded research looking at the comparative patterns of energy consumption by U.S. minorities. This research has strongly suggested that not only are there differences in patterns of energy use but there are also statistically significant differences in the structure of energy demand (see Poyer and Earl 1994, and Poyer and Williams 1993).[2] The implication is that demand elasticities and the effect of changing utility prices on economic welfare are different.

The issue of equity has become more relevant given recent public utility commission decisions approving provisions for low-income rates on the grounds that these rates are justified because of differences in the ".....quantity used, the time when used, the purpose for which used, the duration of use,.....[and that] different charges to different customers for the same service may be based upon their customer characteristics rather than the nature of their service, provided they have a rational basis[3]."

In Table 1, electricity and natural gas consumption for Latino, non-Latino White and Black households at the national and regional levels are shown.[4] These data indicate substantial difference in patterns of electricity and natural gas use by minorities. Latino and Black households consume substantially less electricity and more natural gas (in particular Blacks) than White households. The intra-regional patterns of consumption are strongly influenced by housing patterns and metropolitan location, with minorities being heavily concentrated in older homes, multifamily dwellings, and central cities.

Table 1. 1990 Electricity and Natural Gas Consumption by Census Region (1000 Btu per Household)

Population Group	Northeast	Midwest	South	West	Southwest	National
Electricity						
Latino	19498	24799	37612	21315	24301	26675
Non-Latino White	26052	29446	43672	29758	34883	33307
Non-Latino Black	14306	20246	37570	17671	32861	28782
Natural Gas						
Latino	44063	92609	31735	53057	51619	49184
Non-Latino White	51144	76559	29475	46777	46712	50518
Non-Latino Black	78780	159378	42057	65699	61149	65692

Source: U.S. Department of Energy, Energy Information Administration, 1990 Residential Energy Consumption Survey

[2] Since 1982 the Office of Economic Impact and Diversity (formerly the Office of Minority Economic Impact), U.S. Department of Energy has sponsored the SocioEconomic Research and Analysis Program at Argonne National Laboratory.

[3] See testimony by Trudi Renwick on behalf of the Public Utility Law Project of New York, Inc. before the New York State Public Service Commission, "Proceeding on the Motion of the charges, rules, and regulations of Brooklyn Union Gas Company for gas service," Docket No. 93-G-0941, in which she quotes a recent decision rendered by the New York State Public Service Commission.

[4] The "southwest" combines three census divisions — the West South Central, Mountain and Pacific Census Divisions — in which there is a high concentration of Latino households.

These energy consumption patterns suggest how alternative rate structures might impact these population groups. Specifically, a relative increase in the **electric** customer or access charge would have a more dramatic impact on minorities and a relative increase in the electric energy charge would more dramatically impact White households. In the case of natural gas the relative effects would be reversed.

Figures 1. and 2. demonstrate graphically the variable differences in electricity and natural gas consumption among non-Latinos (White and Black) and Latino households[5]. As the Figures illustrate, the differences vary dramatically from region to region: with non-Latino Black natural gas consumption in the Midwest being nearly twice that of other households in the Region and non-Latino White electricity consumption exceeding the consumption of electricity by Blacks and Latinos in each census region.

Once again, these data strongly suggest that uniformly designed rates will have disparate effects on different population groups with the relative magnitude varying by location. These regions, however, do not represent utility service territories. The question as to the extent to which these relative differences prevail at utility service level is not answered. The distribution shown in Figures 1 and 2 may or may not reflect the distribution that actually prevails in a particular area but the data are quite suggestive.

[5] These data were compiled from the 1990 Residential Energy Consumption Survey issued by the U.S. Department of Energy, Energy Information Administration (See DOE 1993) .

Figure 1. 1990 Electricity Consumption: 1000 Btu per Household

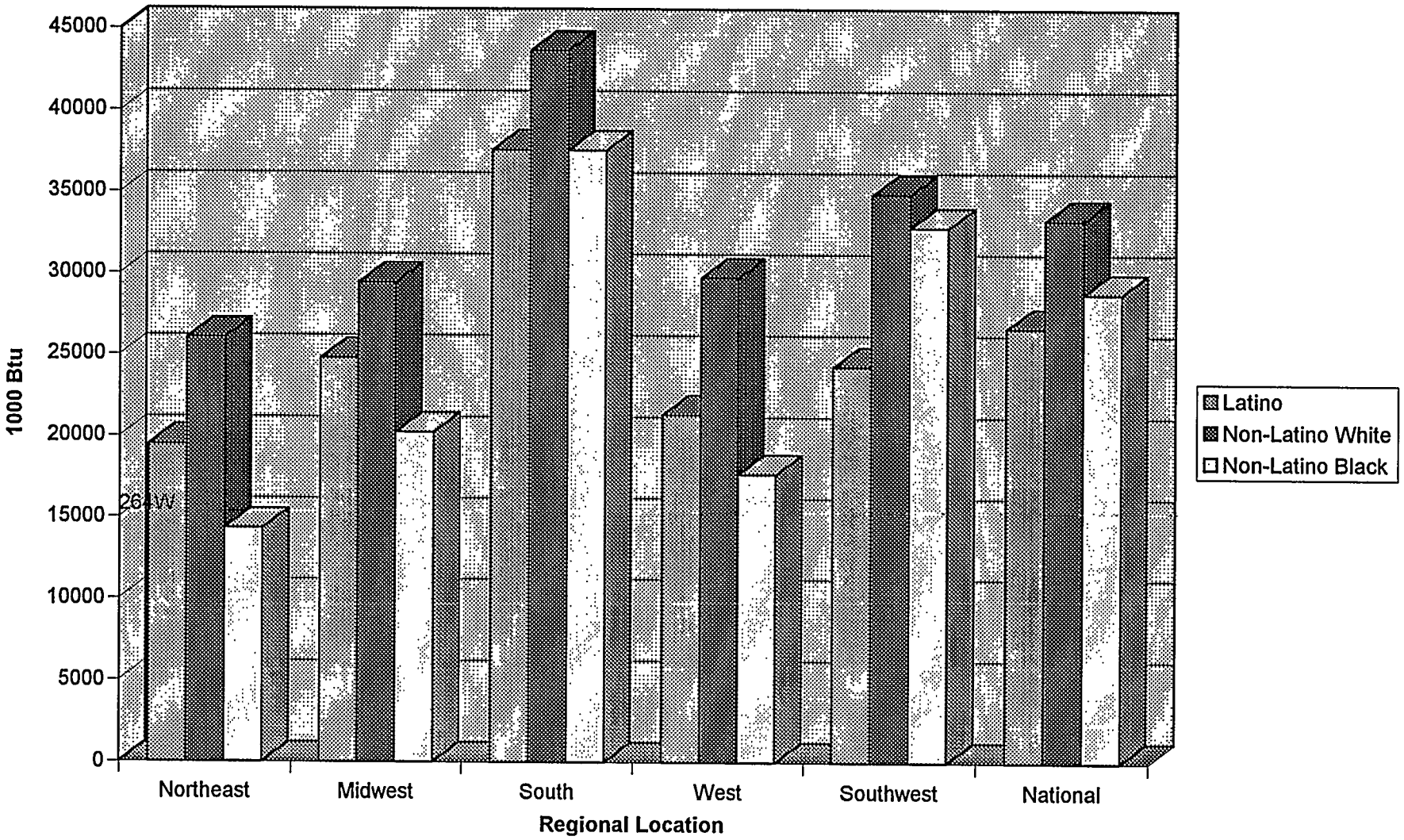


Figure 2. 1990 Natural Gas Consumption: 1000 Btu per Household

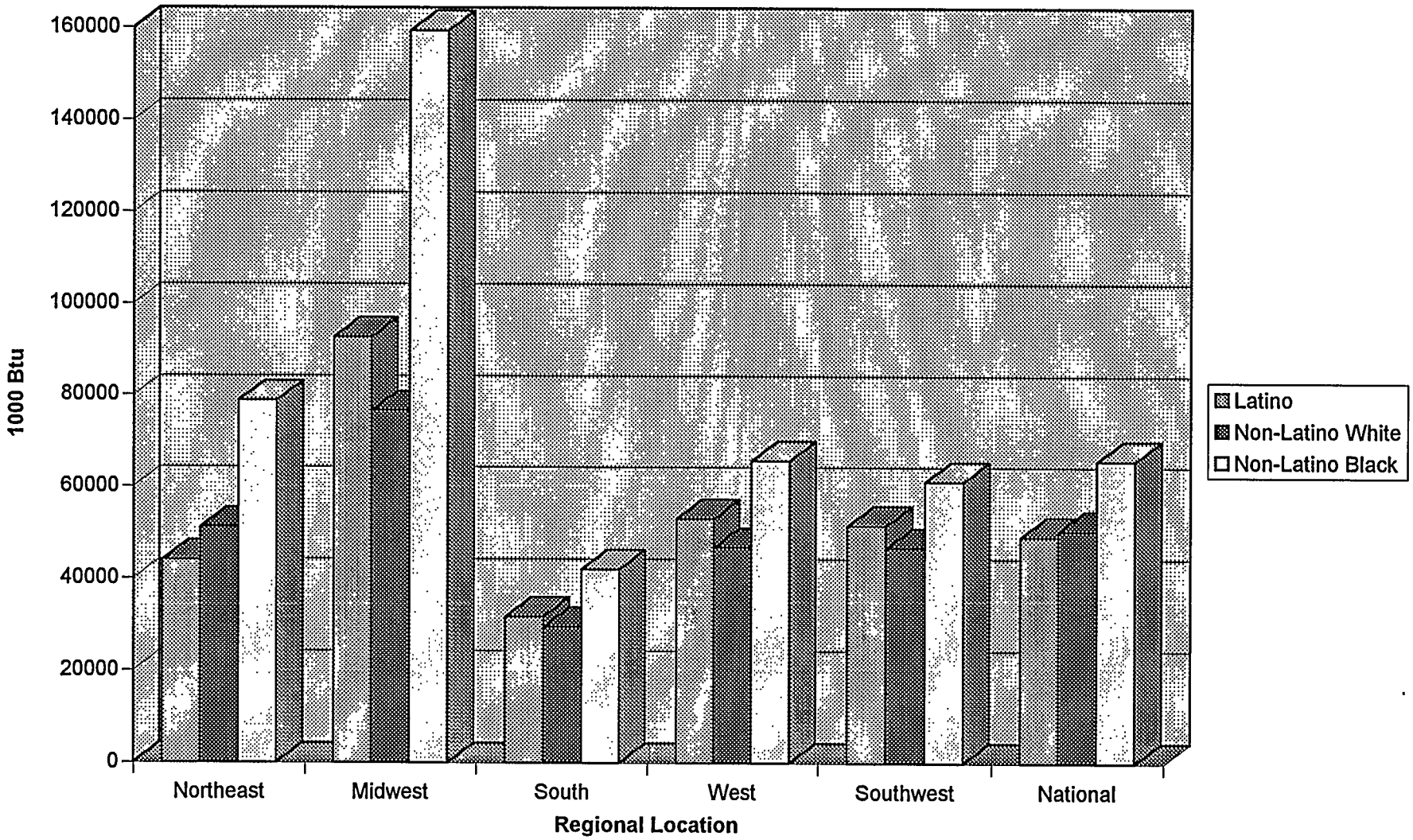


Figure 3. 1990 Composition of Fuel Use: Non-Latino White Households

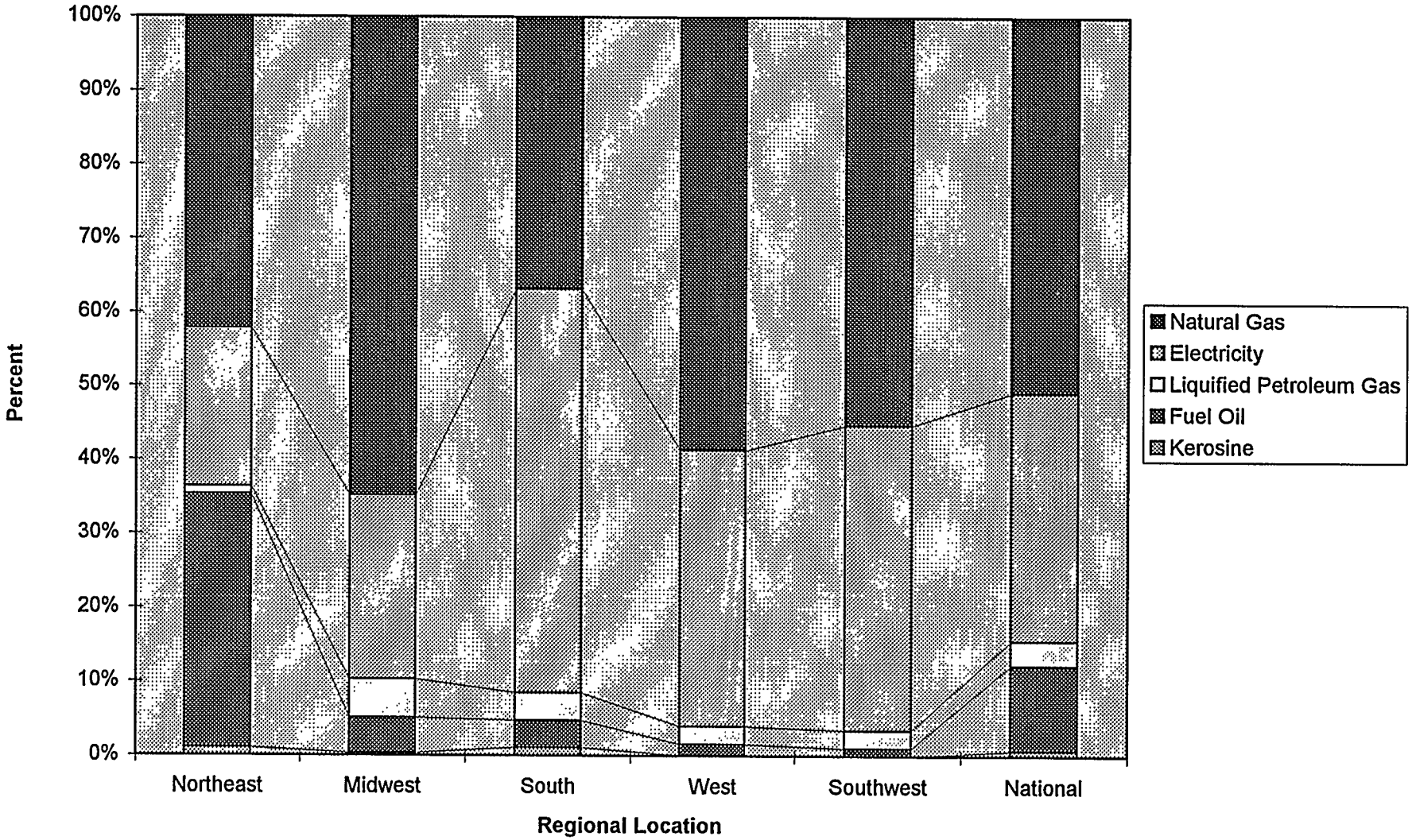


Figure 4. 1990 Composition of Fuel Use: Non-Latino Black Households

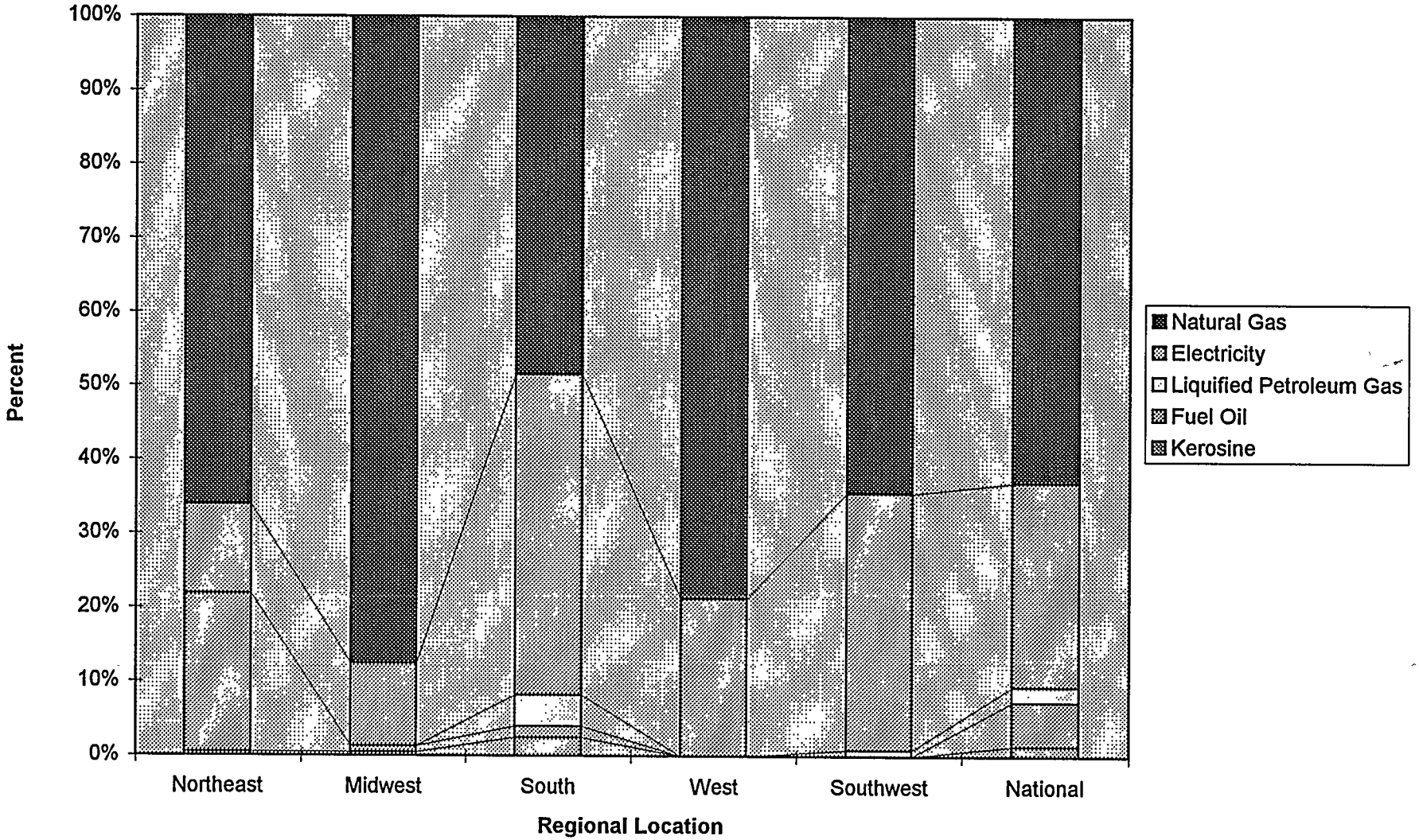
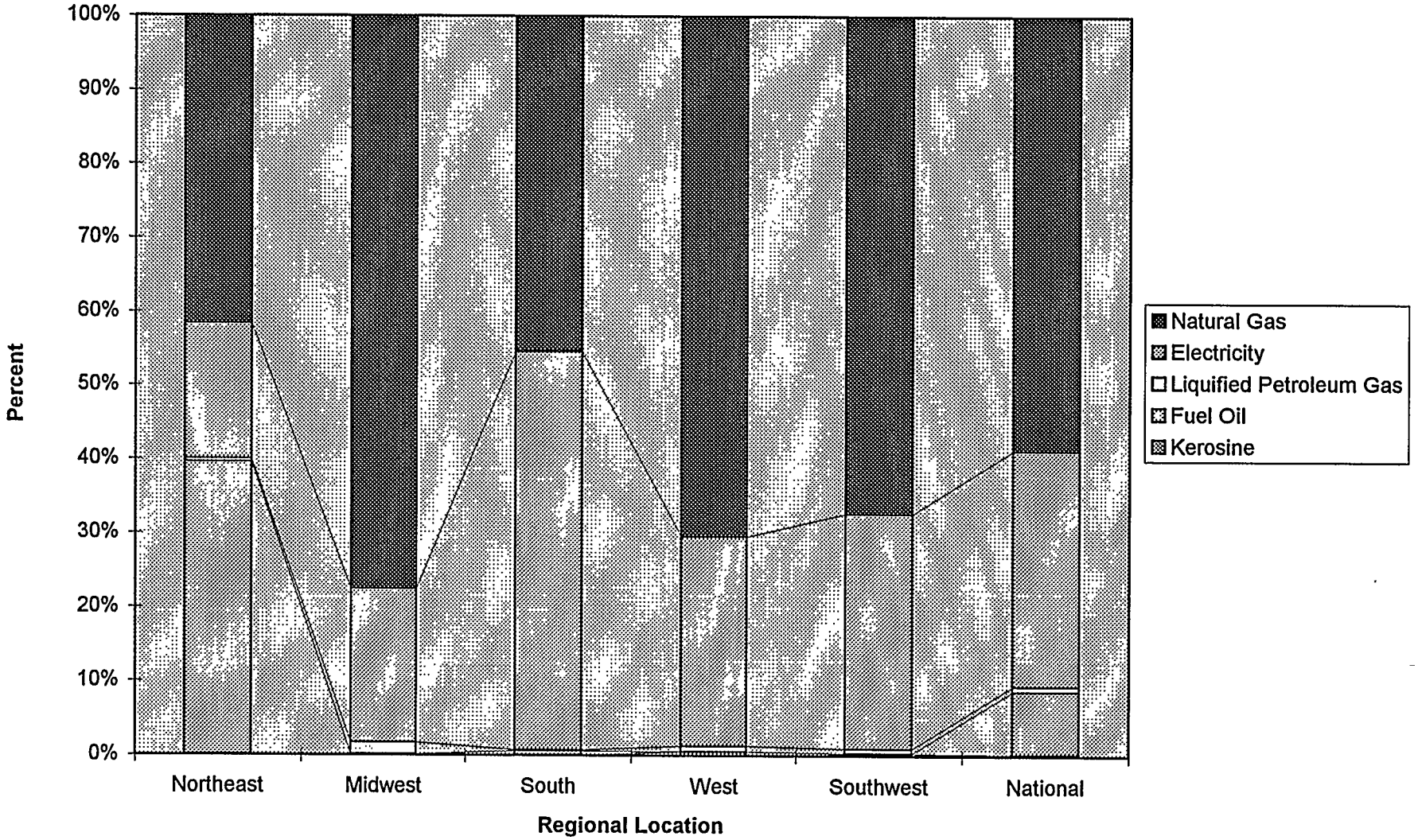


Figure 5. 1990 Composition of Fuel Use: Latino Households



In Figures 3 to 5, the composition of energy consumption is shown for non-Latino White and Black households and Latino households by census region. Once again these data indicate rather significant differences in how energy is consumed among these households. At the national and regional levels, the electric share of total consumption is substantially higher in non-Latino households, whereas natural gas consumption constitutes a relatively substantial share of non-Latino Black household energy consumption.

Although, the preceding data are neither necessary nor sufficient in establishing rigorously a difference in the relative burden of a changing mix of energy prices on the economic welfare of these population groups they are insinuative[6].

Assessing the Effects of Utility Rate Designs

At Argonne under the auspices of the Economic Impact and Diversity Office, U.S. Department of Energy, the Energy Policy Simulation Impact Model (EPSIM) has been developed to assess the impact of policy on different population groups — in particular demand-side management and utility rate schedules.

To illustrate how different rate designs might effect household energy expenditures an example has been constructed and is shown in Tables 2 to 6. In each table, we consider two types of households: one consumes a relatively high amount of electricity and the other a smaller amount. In the initial case, both customers are faced with the same electric tariff and pay $110.00 and $30.00 a month for electricity. Let's assume the regulatory authority for the purpose of achieving greater economic efficiency decides to lower the energy charge in order to put it more in line with the utility's marginal cost and applies the new rate uniformly, i.e. both the high usage and low usage customer are faced with an identical tariff. If the revenue requirement is held constant, the new rate design is revenue neutral and the price elasticity of demand is zero, the new tariff will result in a shift in electric expenditures, with the low-use customer paying more for electricity. The effects of these changes are shown in Table 3.

Under these circumstance a fair and equitable outcome could be guaranteed if the customer charge for the two customers were allowed to differ. Under the conditions assumed earlier and in addition requiring **distributive** neutrality, the new rate schedule would demand a lower customer charge for the high-use customer. This rate design is both revenue and distributive neutral but is also consistent with the idea that a utility's common cost should be distributed on the basis of consumption. In this case, all common cost are covered by the customer charge since the energy charge has been set equal to the utility's marginal costs.

In Tables 5 and 6, the assumption of perfectly inelastic demand is dropped and a own-price demand elasticity of .1 is assumed. In this instance, electricity consumption increases slightly in response to the fall in the marginal price of electricity and total household electricity expenditures increase over the base case. Importantly, in this example there is an improvement in the economic welfare of both electric customers. In the final case, which is summarized in Table 6, revenue neutrality is maintained net of price effects. Here, the customer charge is smaller than in revenue-neutral/zero-elasticity case shown in Table 5. Like the As in the revenue-neutral/zero-elasticity case, the consumer's economic welfare is improved.

In these examples, a **variable** customer charge can be used to achieve efficiency without adversely affecting any particular population group.

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[6] If similar elasticities exist among population groups, higher levels of fuel consumption imply higher prices will affect household economic welfare more acutely. Provided this is true then it would be expected that higher electricity prices would more adversely affect non-Latino White households and higher non-electric energy prices affect Black and Latino households.

Table 2. Electricity Consumption and Expenditures				
Population Category	**Consumption Kwh/mo-hh**	**Customer Charge $/mo**	**Energy Charge $/Kwh**	**Revenue Contribution $/mo**
High Usage	1000	$10.00	$0.10	$110.00
Low Usage	200	$10.00	$0.10	$30.00
Total	1200			$140.00

Table 3. Electricity Consumption and Expenditures: Uniform Customer Charge					
Population Category	**Consumption Kwh/mo-hh**	**Customer Charge $/mo**	**Energy Charge $/Kwh**	**Revenue Contribution $/mo**	**Expenditure Change $/mo**
High Usage	1000	$40.00	$0.05	$90.00	($20.00)
Low Usage	200	$40.00	$0.05	$50.00	$20.00
Total	1200			$140.00	$0.00

Table 4. Electricity Consumption and Expenditures: Non-Uniform Customer Charge					
Population Category	**Consumption Kwh/mo-hh**	**Customer Charge $/mo**	**Energy Charge $/Kwh**	**Revenue Contribution $/mo**	**Expenditure Change $/mo**
High Usage	1000	$60.00	$0.05	$110.00	$0.00
Low Usage	200	$20.00	$0.05	$30.00	$0.00
Total	1200			$140.00	$0.00

Table 5. Electricity Consumption and Expenditures: Non-Zero Elasticity					
Population Category	**Consumption Kwh/mo-hh**	**Customer Charge $/mo**	**Energy Charge $/Kwh**	**Revenue Contribution $/mo**	**Expenditure Change $/mo**
High Usage	1050	$60.00	$0.05	$112.50	$2.50
Low Usage	210	$20.00	$0.05	$30.50	$0.50
Total	1260			$143.00	$3.00

Table 6. Electricity Consumption and Expenditures: Revenue Neutral					
Population Category	**Consumption Kwh/mo-hh**	**Customer Charge $/mo**	**Energy Charge $/Kwh**	**Revenue Contribution $/mo**	**Expenditure Change $/mo**
High Usage	1050	$57.50	$0.05	$110.00	$0.00
Low Usage	210	$19.50	$0.05	$30.00	$0.00
Total	1260			$140.00	$0.00

Conclusions

Within the context of a regulated market, the differentiate of customers can be used beneficially to achieve the goals of economic efficiency and equity. Specifically, in instances were economic efficiency is being promoted through a lowering of the **energy** charge, varying the **customer** charge can be used to ensure fairness and equity.

The allocation of common costs on the basis of usage is attractive in that it can be justified on rational grounds and can also be used to avoid the disproportionate impacts that uniform rate structures are likely to have on different population groups.

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